Wide Area Conventional PMR Systems – Containing A800-SIM

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System Overview

This application note discusses some of the issues and solutions when dealing with large wide area conventional PMR radio networks. Many operators and users of dedicated mobile radio systems have a large operational area to cover – this is particularly so for emergency services and public utilities in many areas of Australia.

Traditionally there are two ways of providing this wide area coverage:

1) Trunked or Cellular based systems
2) Extended networks of conventional PMR systems

In many cases trunked or cellular systems are unsuitable for these emergency service or public utility applications for a number of reasons. Some of these reasons are that trunked/cellular systems:

- are optimised for high density communication areas
- generally require a shared resource leading to conflicting priorities
- require multiple channels per site to achieve efficiency
- significant cost premium over conventional systems – either implementation or ongoing costs
- generally not suitable for all informed systems or for frequent short messages

Conventional PMR networks for these users can offer several advantages:

- lower cost
- suitable for all informed systems
- better suited to low traffic density

The main issues to consider when designing an extended wide area conventional PMR system are:

a) Control of the mobile and portable radios so that they select the best channel for communication – this can be done by having the mobile operator select a channel based on geographical location or by utilising a system such as mobile voting.

b) Cumulative keying delays across the network caused by CTCSS decode periods where multiple link hops are required

c) Ability to reconfigure the system in emergency situations i.e. the system could be split so that a serious incident in one area needn't tie up the whole all informed network. (or systems could be joined for night time operation)

d) Consistent and reproducible connection of bases and links (microwave, landlines etc.) at each site so that equipment can be easily added or removed and to allow ease of servicing.

e) Generally don't want to bring all audio's from each site back to a central point as this requires large overhead in links and hence significant costs.

The Tait Solution

Each of these above issues has been addressed by Tait through the use of SIM based networks. A brief description of the way each of these issues has been addressed by Tait, and, details of the Tait implementation follows:

a) Selection of Best Channel - Mobile Voting

Where mobile voting is used the channels within the network are programmed into the mobile/portable transceiver as a voting group. When the transceiver is in the idle state it scans the channels within the group looking for a received signal. Once a signal is detected the mobile (after a preprogrammed time) checks each of the channels in turn and measures the RSSI (Received Signal Strength) of each channel. This RSSI is then used to determine the best channel for the transceiver to receive on. The transceiver then remains locked onto the channel for the duration of the over and for a programmable hold time afterwards. This hold time is generally programmed for about 5 seconds and means that the mobile does not vote on each and every over. (simple voting takes between 50 – 100mS per channel depending on where in the idle state scan the radio is when a transmission first commences.)

When transmitting the mobile will transmit on the Transmit frequency associated with the last voted channel.

With mobile voting it is important that each of the base station transmitters in the voting group transmits the same information and also that all transmitters are keyed within a limited time of each other. This prevents the mobile from locking onto extraneous remote/weak signals. In addition in the absence of normal traffic the network needs to transmit a “voting pulse” at preset intervals to ensure that the transceivers are operating on the most valid channel if they need to initiate a call.

For some mobile voting equipment it is also important to have consistent tail timers across the system to prevent false voting on weak signals during the tail period. Configured as a hub site the A800-SIM controls the tail timing across the entire system.

b) Cumulative Keying Delays - Fast Keying

Fast Keying of links is used to avoid excessive cumulative delays in keying across an extended network where a number of link hops are required. These delays are particularly an issue where CTCSS tones need to be decoded a number of times across the system.

Fast keying is an issue to provide reliable transmissions – i.e. not cutting off the first words of a transmission, and to provide the best possible conditions for satisfactory mobile voting operation as described above.

CTCSS tones can take typically 150ms to decode (up to 250ms dependent on tone frequency). For a system consisting of 6 cumulative links this equates to approximately 1 second delay from one end of the system to the other – not including transmitter rise time and gating delays (or mobile transceiver CTCSS decoders).

To avoid these delays where multiple link hops are required the Tait A800-SIM utilises a system whereby links are keyed prior to a CTCSS decode to establish the network. Prior to CTCSS decoding on the links “live tone” is transmitted through the system to initiate CTCSS decoders throughout the system. Once CTCSS tones are decoded then tone encoders within the A800-SIM take over and regenerate the CTCSS.

c) System Reconfiguration – System Splitting

The Tait A800-SIM incorporates a system splitting option, which can be controlled by Selcall tones on the system or by an external input to the A800-SIM. This system splitting can be used to:

- separate the system into smaller operational areas when traffic increases – i.e. an emergency situation (this system is normally unsplit), or alternately
- to combine smaller operational networks into a larger network i.e. when traffic decreases such as at night (this system is normally split).

Note - care must be taken when utilising system splitting to ensure that the network remains operationally sound.

d) Consistent connections to site equipment

The A800-SIM is equipped with 8 ports to allow connection of site equipment such as base stations, links, microwave, landlines etc. Each of these 8 ports has separate 15 way D Range connectors for the Transmitter and Receiver however two of the ports can be configured to allow connection via one D Range connector for items such as a line interface or telephone to radio interconnect.

e) Minimise number and cost of links

The A800-SIM allows the one audio path to be daisy chained to a number of sites and directed as configured within the A800-SIM.

Rx Gating, PTT Keying and Audio Distribution are all selectable within the A800-SIM to provide flexibility in network architecture

f) Additional Features

As well as providing those features and facilities described above the A800-SIM also provides the following features:

- when configured as a hub site the A800-SIM provides tail timing to the whole system
- voting pulse to provide the required transmissions to keep mobiles voted to the correct base station
- transmit keying, audio distribution and transmit tail allocation can be configured on a per port basis
- squelch tail elimination – soft off
- combined receiver speaker amplifier
- mains fail alarm option

Examples

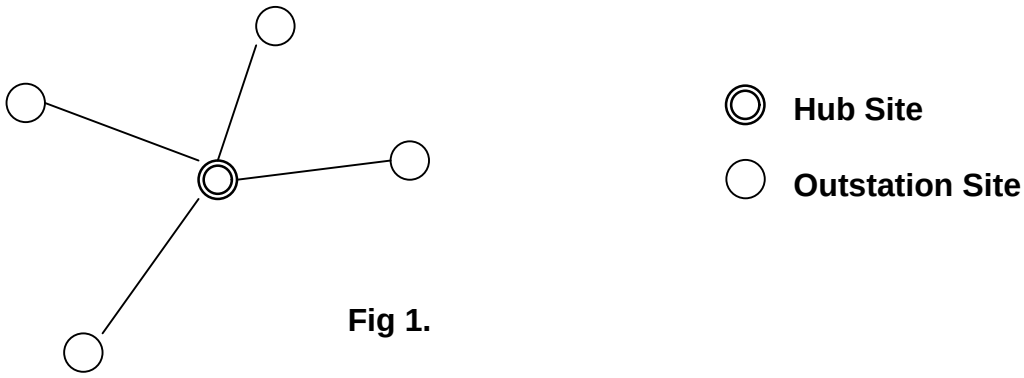

Fig 1.

A simple system might consist of one central hub site and a number of outstation sites linked to the central hub site.

The Hub site provides the tail timing, voting pulse etc. for the entire system

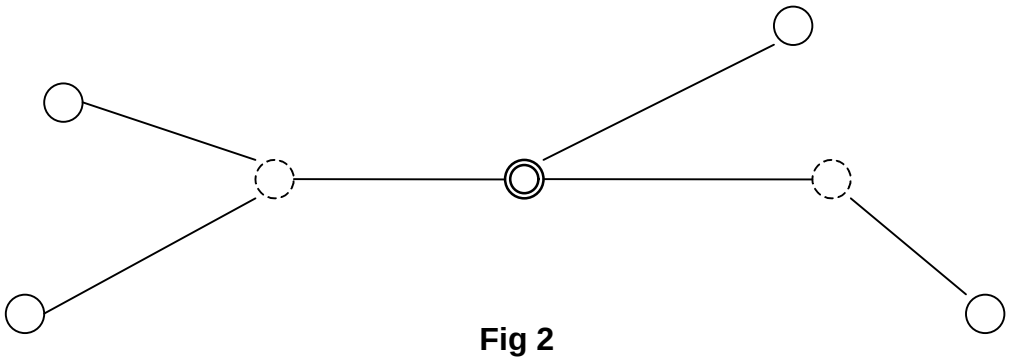

Fig 2

In this case the system is more complex with multiple hop links and again the hub site provides the tail timing and voting pulses for the system.

New issues are introduced however if the above system needs to be split as shown in Fig 3

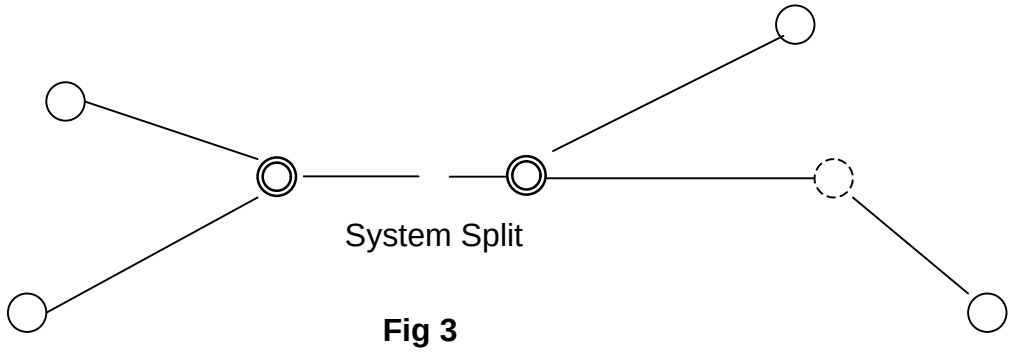

Fig 3

In this case the with the system split it is necessary to have 2 hub sites operating to provide the tail timing, voting pulses etc. for the system.

In addition the mobile must also have the two new voting groups in their channel tables as well as the original one and the mobile operators must know to change to the new voting group as required. Failure to do this will result in unpredictable communications

Conclusion

By addressing the above issues facing the designer of a wide area conventional PMR system the A800-SIM provides a useful and practical piece of equipment enabling many of the problems faced by the designer to be overcome. As an extra advantage the additional features provide improved operational efficiency of the radio system.

For more information on the A800-SIM, please refer to the AM8-SIM.pdf Service Manual. This is available at the Tait web site http://www.taitworld.com/australia/.